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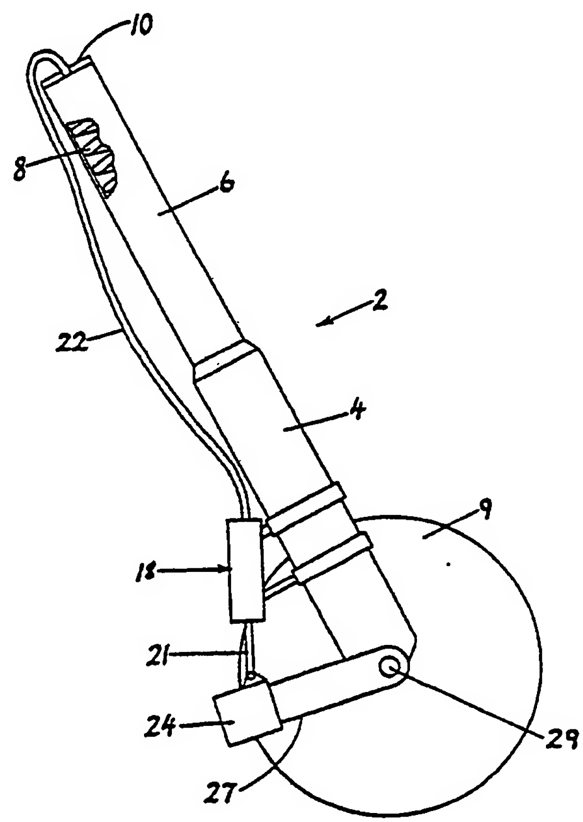
(54) Title: VEHICULAR SUSPENSION

(57) Abstract

A vehicle such as a motor cycle having at least one wheel and including a suspension (2) for resiliently mounting the wheel relative to the chassis. The suspension includes adjustment means (18, 12) which are operable to increase the resilient loading of the suspension when the brakes are applied in order to prevent "brake dive". In the preferred embodiment the suspension includes an actuating hydraulic cylinder (18) which is engaged and moved by the brake arm (27) of the brakes when the brakes are applied in order to pressurize the actuating hydraulic cylinder.



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VEHICULAR SUSPENSION

The present invention relates to a vehicular suspension.

It is well known that the front suspension members of a vehicle become heavily loaded during brake applications. This compression or "dive" has the effect of reducing the effective suspension travel available to cope with road surface irregularities, of affecting the level attitude of the vehicle, and therefore affecting steering geometry.

The need to control this tendency has particular significance in short wheelbase vehicles where small suspension compressions acting over a short base produce more pronounced angles of dive or in vehicles with softly sprung long travel suspensions. It will be appreciated that suspension dive is therefore a particularly serious problem in motorcycle suspensions but is also a problem in other vehicles such as automobiles.

The object of the present invention is to provide a novel form of suspension which ameliorates the effect of suspension dive.

According to the present invention there is provided a vehicle comprising a chassis, at least one wheel, a suspension for resiliently mounting the wheel relative to the chassis, brake means for applying a braking torque to said wheel, suspension adjustment means coupled to said brake means and operable to increase resilient loading of the suspension when said brake means produces a braking torque on said wheel and means for transmitting at least part of the reaction torque to the braking torque to said adjustment means. In the arrangement defined above the suspension adjustment means are operated independently of any loading which might be applied to the suspension means in consequence of braking of the vehicle. Thus, the arrangement of the invention can be considered to increase the resistance of the suspension under vehicle braking to thereby effectively reduce suspension dive.

Preferably, the suspension includes a compression spring and said suspension adjustment means is operable to compress the spring.

Preferably further, the suspension includes a telescopic suspension strut having first and second tubular members telescopically coupled together with said compression spring therein and wherein said adjustment means is operable to adjust the compressive forces applied to said spring without affecting the relative positions of said first and second members.

Preferably further, said suspension adjustment means includes an actuating hydraulic cylinder arranged to be pressurized by reaction torques to said braking torque, said adjustment means including a piston located in the telescopic suspension strut, and hydraulic line being connected between said cylinder and the strut, the arrangement being such that variations of pressure within said cylinder causes the piston to move to thereby compress said spring.

The hydraulic system could have a facility for being pre-charged with hydraulic pressure so that no initial movement of the master cylinder is spent in bringing the system to operating pressure. Further, this facility could be employed to provide a means of adjusting the suspension pre-load, by pumping up the system to increase the initial spring pre-load.

Preferably further, the brake comprises a disc brake and the arrangement is such that said hydraulic cylinder is engaged by the brake caliper or pad in the disc brake. Where the brake comprises a drum brake the hydraulic cylinder is engaged by the brake shoes.

The invention will now be further described with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of a front suspension and brake of a motorcycle,

Figures 2 and 3 are more detailed views of parts of the suspension shown in Figure 1.

Figure 1 illustrates part of a suspension and brake system for a motorcycle. It comprises a telescopic suspension strut 2 comprising a lower tubular portion 4, the lower end of which is connected to the bearing assembly (not shown) for the wheel. The strut includes an upper tubular portion 6 which is telescopically mounted within the portion 4 and located within the portion 6 is a compression spring 8. Normally the upper end of the compression spring 8 bears against the lower face of a suspension strut cap 10 which is fixed in position in the top of the portion 6.

In accordance with the invention, a piston member 12 is interposed between the cap 10 and the spring 8, as best seen in Figure 2, such that the spring 8 bears against the lower face of the piston. In this arrangement the cap 10 is formed with a projecting spigot 12 on its lower face, the spigot 13 including a fluid passage 14. The piston member 12 is of generally tubular shape and its opening 15 is of complementary shape to spigot 13. An O-ring seal 17 is formed in the opening to form a fluid seal against the spigot 13. The arrangement is such that when fluid

pressure within the line 14 is sufficiently high to overcome the compressive force of the spring 8, the piston member 12 will move downwardly and compress the spring. If the suspension strut 2 is otherwise static, the downward movement of the piston member 12 and compression of the spring 8 occurs independently of any relative movement of the portions 4 and 6 of the strut. Thus, movement of the piston 12 effectively alters the "stiffness" of the suspension.

Returning now to Figure 1 it will be seen that the arrangement includes an actuating hydraulic cylinder 18 connected to the lower portion 4 of the strut and having a movable piston 20 slidably mounted therein. A piston rod 21 is connected to or located adjacent to the lower face 23 of the piston 20. Movement of the rod 21 causes movement of the piston 20. An hydraulic line 22 extends from the cylinder 18 to connect with the line 14 through the cap 10. The rod 21 is located so that it is moved when the brakes of the cycle are applied.

In the illustrated arrangement, the lower end of the rod 21 is pivotally connected by pivot coupling 25 to the brake arm 27 upon which the disc brake caliper 24 is mounted. Brake pads (not shown) are carried by the caliper 24 and engage a brake disc 9 on application of the brakes of the cycle. Contrary to normal practice, the arm 27 is mounted such that it can undergo limited rotational movement about the axle 29 of the cycle. When the brakes are applied, the arm 27 moves, in the direction towards the piston

20, and this movement is resisted by build up of fluid pressure in the cylinder 18 acting through the rod 21. Thus the reaction force required for braking is transmitted through the rod 21 and thus increases greatly the pressure within the cylinder 18 and so compresses the spring 8 directly corresponding to applied braking torques. The upper end 31 of the rod 21 is rounded and is received within a rounded cavity 33 in the lower face 23 of the piston 20 so that the inter-engaging faces can tolerate relative rotation which is required in the geometry of the arrangement. The rod 21 is provided with a collar 35 which is engageable with the lower wall 37 of the cylinder 18 and so limits downward movement of the rod 21 and thus the arm 27.

The amount of compression of the spring 8 will of course depend on the type of motorcycle and its suspension. Normally the compression would vary from said 30 to 120mm in response to maximum braking torques;a prototype with a stroke of 45.5mm has been tested and found to be satisfactory. It would be possible, by providing a means of adjustment at the piston 20 to vary the length of stroke, to control the amount of spring compression desired. The bore and stroke of the master cylinder are in one prototype 15mm and 40mm respectively. The hydraulic ratio between the master cylinder and the two slave cylinders is 1.125:1 and this has functioned satisfactorily. The peak pressure developed was about

2700 psi and a precharge pressure of 270 psi.

The advantages of the suspension of the invention include:

1. <u>Adjustability</u>: By limiting the stroke of the master cylinder by a mechanical stop or adjuster, the amount of pre-load input into the spring can be varied infinitely from zero compensation to the full "dive" compensation designed into the system. Therefore the suspension can be adjusted to the particular requirements of a road or race situation.

2. <u>Fail-Safe Operation</u>: In the event of any failure in the "anti-dive" system, the motorcycle suspension will continue to perform normally except that no dive compensation will operate and "dive" will occur. No serious effect on the safe operation of the suspension is possible with a failure in this system of anti-dive.

3. <u>Roadholding and Stability</u>: This system incorporates all the features which make "anti-dive" technically desirable. In addition, the particular method of achieving this result means that the suspension retains its intended compliance and travel to accommodate suspension deflections over road surface irregularities. In this system neither the spring rate, nor the compression damping characteristics, which control the resistance to suspension deflection, are affected in any way. The suspension is not stiffened, rather the additional load is cancelled out by increased pre-load.

4. Ease of Application: To avoid major design changes to standard telescopic forks it is intended to locate the hydraulic slave piston 12 within the internal diameter cavity of the coil spring 8. The only limitation to this which may be experienced is that with smaller diameter fork tubes it may not be possible to allow sufficient wall thickness in the slave cylinder to withstand the high hydraulic line pressure operating in the system. However, no difficulty should arise with fork tubes of over 35mm Ø.

5. Independent from Braking System: The device is entirely separate from the hydraulics of the braking system. No fault in the "anti-dive" system can therefore interfere with the safe operation of the brake system. Servicing and maintenance is also simplified in that both systems can be treated individually.

6. Suitable for Various Applications: The system is readily adaptable to all front brake system variants including Twin Disc Brakes, Single Disc Brake, Drum Brake with single backing plate and Drum Brake with twin backing plates.

Many modifications of course will be readily apparent. For instance, the piston 12 could be located at the lower end of the suspension strut and still have the same effect. Further, the whole arm 27 need not be located in a movable mounting, it being

sufficient for the brake pads to be movable. Further, it would be possible to arrange for the adjustment to be made by a mechanical linkage although the hydraulic arrangement is seen to be simpler to implement. The cylinder 18 and piston 21 could be extended rather than compressed and still arranged to produce the same effect.

The same effect could be achieved in an air suspension system.

Many further modifications will be apparent to those skilled in the art.

CLAIMS:

1. A vehicle comprising a chassis, at least one wheel, a suspension (2) for resiliently mounting the wheel relative to the chassis, brake means (9, 24) for applying a braking torque to said wheel, and suspension adjustment means (18, 12) coupled to said brake means operable to increase resilient loading of the suspension when said brake means produces a braking torque on said wheel, and means (21, 27) for transmitting at least part of the reaction torque to the braking torque to said adjustment means.

2. A vehicle as claimed in claim 1 wherein the suspension includes a compression spring (8) and said suspension adjustment means is operable to compress the spring.

3. A vehicle as claimed in claim 2 wherein the suspension includes a telescopic suspension strut having first and second tubular members (4, 6) telescopically coupled together with said compression spring therein and wherein said adjustment means is operable to adjust the compression forces applied to said spring without affecting the relative positions of said first and second members.

4. A vehicle as claimed in claim 3 wherein said suspension adjustment means includes an actuating hydraulic cylinder (18) arranged to be pressurized by reaction torques to said braking torque, said adjustment means including a piston (12) located in

the telescopic suspension strut, and an hydraulic line (22) being connected between said cylinder and the strut, the arrangement being such that variations of pressure within said cylinder causes the piston to move to thereby compress said spring.

5. A vehicle as claimed in claim 4 wherein the brake means includes a brake disc (9) connected to the said wheel, a caliper (24) having brake pads for engaging said disc when said brakes are operated, said caliper being mounted upon an arm (27) which is mounted on the chassis for limited movement relative thereto in response to operation of said brake means, movement of said arm being arranged to cause operation of said actuating hydraulic cylinder.

6. A vehicle as claimed in claim 5 wherein said actuating hydraulic cylinder includes a piston (20) and a piston actuating rod (21), said rod being connected to or engaged by said arm.

7. A vehicle as claimed in any one of claims 1 to 7 wherein the vehicle comprises a motor cycle and said one wheel comprises the front wheel thereof.

8. A vehicle as claimed in any one of claims 4 to 7 wherein said hydraulic cylinder is precharged to a predetermined pressure.

9. A vehicle as claimed in claim 8 wherein said predetermined pressure is about 270 psi and wherein the peak pressure developed in said cylinder is about 2700 psi.

10. A vehicle as claimed in any preceding claim wherein the maximum stroke of the suspension adjustment means is in the range of 30 to 120mm.

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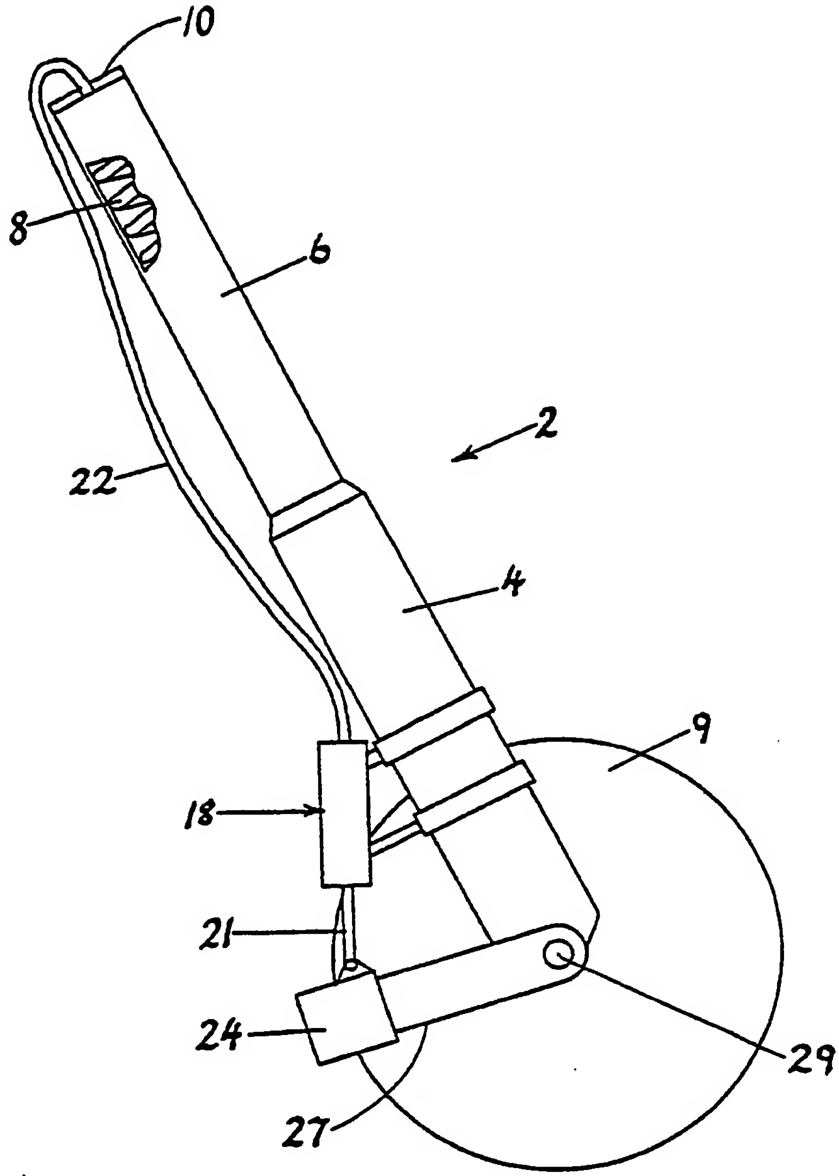

FIG 1.

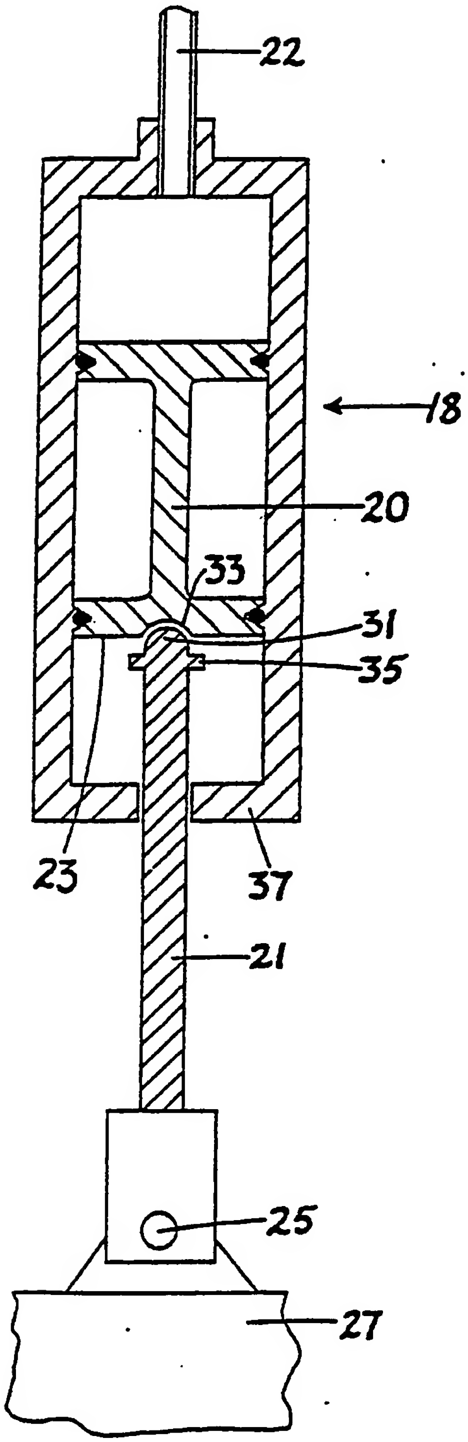

FIG 2

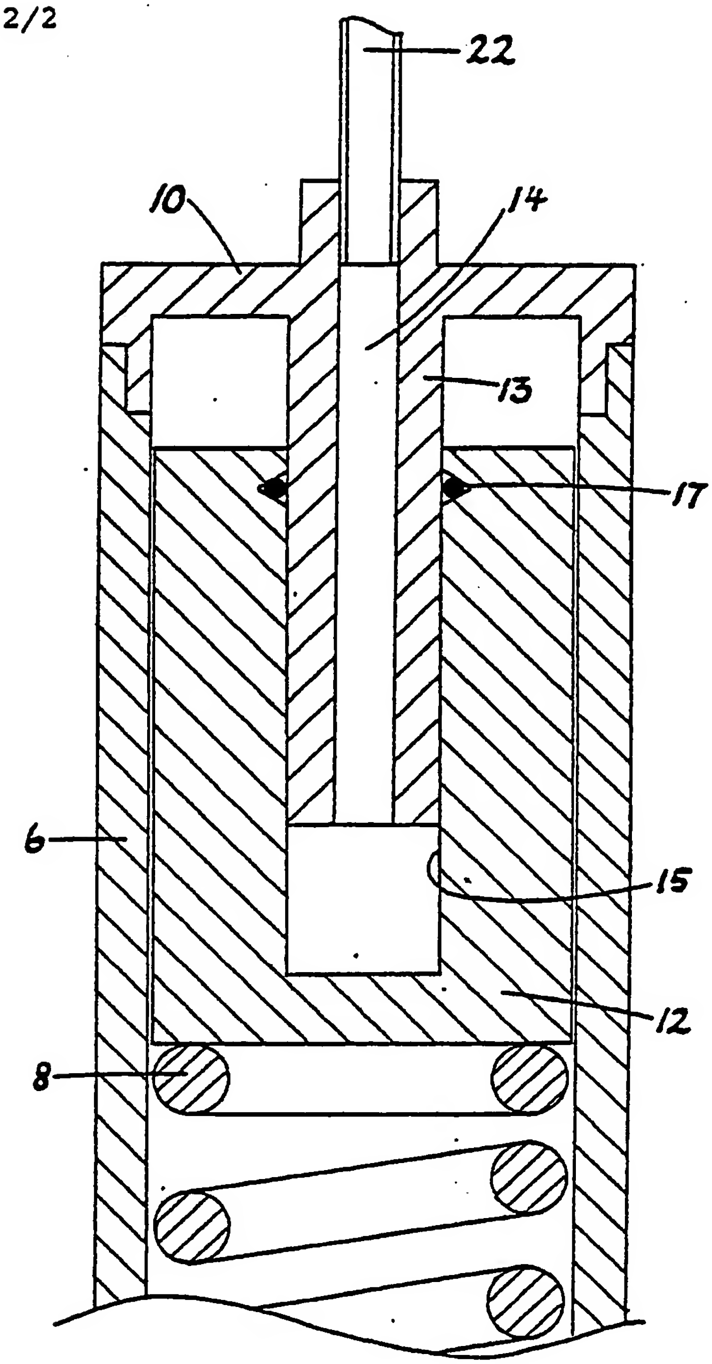

FIG 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 81/00102

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

B60G 17/01, 15/01

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC	B60G 15/02, 17/02

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

AU:IPC as above; Australian Classification 96.5

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category [*]	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	AU, B, 64294/69 (439559), published 1971, May 27, Thompson and Mezey.	
A	AU, A, 26115/30, published 1931, February 12, Ammirandoli and Baldi.	
A	GB, A, 796880, published 1958, June 18, Regie Nationale des Usines Renault (& FR, A, 1098852)	
A	FR, A, 1113716, published 1956, April 3, Regie Nationale des Usines Renault.	
A	US, A, 2342381, published 1944, February 22, Thornhill	

* Special categories of cited documents: [15]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
17 September 1981 (17.09.81)	25 September 1981 (25.09.81)
International Searching Authority [1]	**Signature of Authorized Officer [20]**
Australian Patent Office	R.J. Sawyer

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